George Washington University,
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1853

CIRCULAR

OF THE

COLUMBIAN COLLEGE,

WASHINGTON,

DISTRICT OF COLUMBIA,

1853.

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COLUMBIAN COLLEGE, D. C.

The Board of Trustees of this Institution, encouraged by the recent successful effort to enlarge its endowment, and by the increasing interest which has been manifested by its friends, have adopted several plans of improvement, which they trust will meet with public favor, and tend essentially to promote its prosperity and usefulness.

With a view of giving to the several Departments of Instruction a wider extension and greater efficiency, and, at the same time, of rendering the advantages of the College available to a larger and more varied class of students, some important changes have been made in the order and arrangement of the studies. A distinct Course has been established, denominated *The Scientific Course*, and the degree of *Bachelor of Philosophy*, (*B. P.*,) attached to it. It will occupy about three years, and will embrace all the studies (with some in addition) of the regular course required for the degree of Bachelor of Arts, with the exception of the *Ancient Languages*. This course will be specially adapted to those who desire to obtain what is called a *Practical Education*, as the Mathematical and Scientific Studies will receive greater prominence than usual, especially in their application to the Arts and business of life. Those who may wish to become Practical Surveyors, Engineers, or Agriculturists, will be enabled, with the advice of the Faculty, to select their studies with particular reference

to these objects, and will receive the aid of appropriate Lectures and Illustrations.

The doors of the College will also be opened to those who, under its general regulations, may wish to pursue any department of study for any length of time. Such persons may, with the concurrence of the Faculty, select those branches which are suited to their views and objects in life, and, upon examination, may receive a regular certificate of their standing and proficiency in the same.

The number of officers and instructors has lately been increased, and others will be added, as the wants of the several departments may require. Measures are in progress for securing, immediately, the services of a gentleman eminently qualified for the department of Chemistry, Geology, Mineralogy, and Botany, whose lectures and illustrations will add much to the interest and profit of these studies.

COLLEGE SESSION.

Hereafter, the Collegiate year will consist of one continuous Session, beginning on the last Wednesday of September, and closing on the last Wednesday in June; on which day *the Annual Commencement for conferring Degrees* will be held. Students may be admitted at any time, but the opening of the session is preferable.

COURSES OF STUDY, DEGREES, ETC.

There will be three regular Courses of Study, and three Degrees conferred, viz: that of Bachelor of Arts, (A. B.)—of Bachelor of Philosophy, (B. P.)—and of Master of Arts, (A. M.;) which last degree will be conferred, not as heretofore, as a matter of course, but upon those who have pursued a prescribed course of study, and have sustained a full and satisfactory examination therein.

THE BACHELOR OF ARTS COURSE.

Candidates for admission to this course must be well acquainted with the common branches of an English education; with the elements of the Latin and Greek languages, so as to be able to construe, with ease, Cæsar, Sallust, Virgil, Cicero's Orations; and the Gospels in Greek, and the Greek Reader; and for an advanced standing, must be well versed in the preceding studies of the class which they propose to enter. They must also bring satisfactory testimonials of a good moral character; and if from another College, a certificate of honorable dismission. The subsequent studies will be, for the

FRESHMAN CLASS.

Selections from Ovid, do. from Livy; from Xenophon's Anabasis and Cyropædia; together with Latin and Greek Prose Composition.

Greek and Roman Antiquities, and Ancient and Modern Geography and History.

In *Mathematics*—Algebra and Geometry.

SOPHOMORE CLASS.

Selections from Cicero and Horace; do. from Herodotus or Thucydides, and Homer; Prose Composition and Antiquities continued.

In *Mathematics*—Algebra and Geometry, with their applications, completed; Plane and Spherical Trigonometry.

Logic, or Rhetoric; Natural History, in some of its branches; Ancient and Modern History.

JUNIOR CLASS.

Euripides or Sophocles; Selections from Demosthenes; Extracts from Cicero's Philosophical Works, and from Tacitus.

In *Mathematics*—Topography, including Mensuration of Heights and Distances, Surveying, Leveling, Navigation, and Nautical Astronomy; Conic Sections.

In *Natural Philosophy*—Mechanics and Hydrostatics.

Rhetoric and Logic completed.

Evidences of Natural and Revealed Religion.

French or other Modern Language; History.

SENIOR CLASS.

Intellectual and Moral Philosophy; Political Economy; American Constitutions; Extracts from Cicero's and Xenophon's Philosophical Works.

Natural Philosophy—Pneumatics, Acoustics, Optics, Magnetism, and Electricity; Astronomy; Chemistry, Geology, Mineralogy and Botany; Animal and Vegetable Physiology, with Lectures and Illustrations upon these several subjects.

Some of the studies in this course may, with the approbation of the Faculty, be exchanged for those deemed by them equivalent, of another department, provided the general character of a full Classical Course be preserved.

The time usually allotted to this course is four years; but the Faculty may, when the circumstances in their opinion justify it, admit students to an examination for the degree in a shorter time.

THE SCIENTIFIC COURSE.

For admission, the student must be well prepared in the common branches of an English education. The regular studies of the course will be, for the

First Year,

Algebra, Davies' First Lessons, and Davies' Bourdon; Arithmetic reviewed; Plane and Solid Geometry; Mensuration of Superficies and Solids; Ancient and Modern Geography and History; the French Language.

SECOND YEAR.

Plane and Spherical Trigonometry, with their applications; Topography, including Mensuration of Heights and Distances, Surveying, Leveling, Navigation, and Nautical Astronomy; Descriptive Geometry, including Spherical Projections, Shadows, and Perspective; Analytical Geometry, including Conic Sections; Integral and Differential Calculus.

Natural Philosophy—Mechanics and Hydrostatics; Logic and Rhetoric; French or other Modern Language; History.

THIRD YEAR.

Natural Philosophy—Pneumatics, Acoustics, Optics, Magnetism, and Electricity; Chemistry, Geology, Mineralogy, Botany, Animal and Vegetable Physiology, with illustrative Lectures in each; Intellectual and Moral Philosophy; Political Economy; American Constitutions; Lectures on Natural and Revealed Religion; Modern Languages and History.

For a portion of the studies here designated, there may, with the concurrence of the Faculty, be substituted an equivalent amount of the Classics, provided the leading character of a Scientific Course be preserved.

The time usually occupied by this course will be *three years;* but the Faculty may admit students to an examination for the degree at an earlier period, when the circumstances, in their opinion, justify it.

Young men who are not candidates for a degree may select any portion of this course, and prosecute it in connection with the regular classes, on complying with the general regulation of taking such studies as, in the judgment of the Faculty, they can profitably pursue, and as many of them as are necessary fully to occupy their time.

THE MASTER OF ARTS COURSE.

This will embrace all the English studies, and all the Classics, of the regular Bachelor of Arts course, with the addition of one author each, in the Latin and Greek Languages. It will include, also, all

the Mathematical and Scientific studies of the Bachelor of Philosophy course, excepting such as may have been substituted for *extra* studies which the Faculty shall deem equivalent, in some other Department. Candidates for this degree must not only have sustained, satisfactorily, the regular examinations in their respective classes, but will be subjected to a general examination upon the whole course here prescribed; to which latter, however, none will be admitted but such as have attained a higher than a *medium* standing in their respective classes. Graduates of the College, who may have made a proficiency in any branch of professional study, which the Faculty shall deem equivalent to the above prescribed course, will be entitled to this degree.

EXAMINATIONS.

There will be regular examinations upon all the studies of each session. Care will be taken that these shall be thorough and effective, such as to afford a fair test of each student's attainments in all the branches to which he has attended.

RHETORICAL EXERCISES.

Declamation and Composition are attended to, alternately, each week, by all the Classes. Orations are written and delivered, once in three months, by the Junior and Senior Classes, and by the most advanced class in the Scientific Course.

Lectures will be given to the higher classes, on the subjects of their respective studies. Lectures will also be given on Anatomy, Physiology, and Hygiene, in the course of the year.

PREPARATORY DEPARTMENT.

This Department has been removed to a commodious building on the College premises, which has been handsomely fitted up for its reception. It has been placed under careful and efficient management, and will afford the best advantages for laying the foundation of a thorough classical and mathematical education. It has an able and experienced teacher, and will be under the general supervision of the Faculty.

Boarding pupils will be received under the immediate care and direction of the Principal, and at about the same expense as full College students.

FACULTY.

REV. JOEL S. BACON, D. D., PRESIDENT, and
Professor of Intellectual and Moral Philosophy.

WM. RUGGLES, LL.D.,
Professor of Mathematics and Astronomy.

REV. A. J. HUNTINGTON, A. M.,
Professor of the Latin and Greek Languages and Literature.

R. P. LATHAM, A. M.,
Adjunct Professor of Mathematics.

WM. P. JOHNSTON, M. D.,
College Professor of Anatomy and Physiology.

Professor of Chemistry and Natural History.

LUTHER R. GWALTNEY, A. B.,
Tutor in the Languages.

D. E. GROUX,
Teacher of the French, Spanish, and German Languages.

GEORGE S. BACON, A. B.,
Principal of the Preparatory Department.

CHARGES.

Tuition, (for the session of nine months)	$40 00
Use of room, furniture, library, and attendance	30 00
Table and servants, (per week)	2 25

To those students who *do not board in College*, the charge for tuition is the same; and for room, furniture, library, and attendance, $25 per session.

All students who enter College pay a matriculation fee of $10, which is paid but once. There is also a small charge of $3 per session, for contingencies. The study of French, or any other modern language, is an extra charge. Fuel and lights are furnished at cost, and washing at 37½ cents per dozen.

A less expensive table is provided for those who, for the sake of economy, choose to dispense with tea and coffee, and a few other articles. The board at this table is charged at $1 50 per week, thus reducing the expenses about $30 per annum.

The necessary College expenses of a boarding student, exclusive of books and stationery, will not exceed, at the highest price of board, $190, and at the lower price of board, $150 per annum.

All the College bills are payable one half Session in advance. No abatement is made in the bills for board, on account of an absence of less than one month, except in cases of protracted illness.

GENERAL REMARKS.

The College is delightfully situated on an eminence which overlooks the city of Washington, the Capitol, and other Public Buildings; and commands a fine view of the Potomac, with the surrounding country, for many miles in extent. For beauty and healthfulness of position, it is unsurpassed; and its local advantages are not equalled by those of any other Institution in the country.

Its vicinity to the National Metropolis affords to young men the opportunity of becoming acquainted with distinguished public characters; of understanding the nature and operations of our Government; and of witnessing the highest exhibitions of talent in the Halls of Congress and in the Supreme Court of the United States. This is deemed of great importance, especially to those who are destined for public life, and its results are seen in the success of many who have gone out from the College, and are now filling distinguished stations of honor and usefulness in society.

The city of Washington is already becoming a place of great attractions for persons engaged in scientific and literary pursuits. The National Observatory, established by Congress, is in full and successful operation. It is furnished with instruments of great value and perfection, which are employed, under able direction, in making important Astronomical observations. The "Smithsonian Institution" is now in progress, and its ample buildings are nearly completed. The income of its large fund, which amounts to some six or seven hundred thousand dollars, is to be here employed "for the increase and diffusion of knowledge." The plan already adopted by the Regents covers a very wide field, embracing an extensive Library; choice collections in the Arts and in Natural History; original experiments and investigations; and Public Lectures by men of the highest eminence in the several departments of science and learning. Access to these Institutions, and

others of like character, afford very great opportunities for improvement, especially in those branches which are not embraced in the ordinary course of a public education, and present strong additional inducements to young men for entering a College where such advantages can be enjoyed.

Much pains has been taken to limit the expenses of the College, so as to place its means of education within the reach of the greatest number possible. The charges, it will be seen, are moderate, when compared with those of other institutions of like grade. It was a prominent object with its founders, and one which has been steadily kept in view, to afford aid and encouragement to young men preparing for the Christian ministry. To such, when their circumstances render it desirable, the *tuition* is gratuitous, and in some instances no charge is made except for board, which may be had at one table for $1 50 per week. Such additional assistance, as is compatible with the other duties of the College, will be afforded them in directing their studies, and imparting Biblical instruction.

The Buildings have recently undergone thorough repairs, and the grounds are being laid out and improved, in a manner that will add much to the attractions of its beautiful situation. It is believed the College never presented so strong inducements as it now does, to young men who desire to obtain a thorough and liberal education.

LECTURE,

INTRODUCTORY TO THE COURSE ON

Chemistry and Pharmacy,

IN THE

NATIONAL MEDICAL COLLEGE,

WASHINGTON, D. C.,

BY

LEWIS H. STEINER, M. D.,
PROFESSOR OF CHEMISTRY AND PHARMACY.

DELIVERED OCTOBER 31ST., 1853.

CHAMBERSBURG, PA.:
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LECTURE.

GENTLEMEN:

THE progress of science, in modern times, has been such as to astonish every one viewing it from a stand-point outside of itself, while those actively engaged in effecting this progressive movement, seem hardly aware of the great discoveries which attend their daily labors. If an argument were needed to prove the progressive character of the human mind,—an idea which indeed is implanted in that mind by the Creator and dimly foreshadowed in the law which provides for the development of all organic creation from the germ to full maturity,—if such an argument be needed, the wonderful progress of science would go far to supply the deficiency. The law of progress applies to all creation: with the animal it perishes with the death of the individual; with man it does not die, in two senses,—in the one, it continues in another world, (so far as the immortal part is concerned) though, with more rapidity, hastening on to the attainment of greater and still greater good, or greater and still greater ill;—in the other, it lives on earth in the works he leaves behind him, the character of which depends greatly on the age in which he has lived and whose wants have called forth the relative faculties of mind necessary to minister effectually to them.

The wants of any particular age thus give direction to the mental labors of its great men, and as these are theoretical or practical, warlike or pacific, we find that the great works peculiar to the age are philosophical or practical, abounding in refinements of the art of war, or in the more harmonious and peaceful evidences of philanthrophy. With all this, however,

it seems that, in the course of humanity on earth, there has been predominant since its very beginning an onward tendency towards a fuller development of its faculties and the productions of those fruits of mind, which afford perennial evidence of the greatness of its Creator. This onward tendency may seem at times to be retarded in various ways, and retrogression rather than progression to take place. During such intervals, strength is gained, which pushes on then with a vigor much increased by the delay. The progress has been not unaptly compared to that of a spiral where the curve, it is true, seems to return to the point from whence it started, but in fact is all the while advancing onward from that point.

Now in the spiral-progressive development of the human mind, different divisions of human knowledge, at different periods of time, seem almost exclusively to claim the attention of the race. This predominance does not take place blindly, but in obedience also to regular laws, which require that certain points should be fully elucidated before we are prepared for the attentive and serious consideration of others. There is thus a logical order, which marks the course of human investigation, not only in each particular individual, but in mankind as a whole,—an order, which is carried out most beautifully in the history of the attainment of knowledge, and which, when violated, results in the production of baseless theories and crude opinions, to be overturned by the more thorough investigations of after days. We see a practical exemplification of this, in the results attained by the Alchemy of the Middle Ages, when the attention of a few was turned to the cultivation of science, before the necessary preparation had been made for its proper study. But it must also be remarked that even a violation of such a logical order, though not resulting in the formation of *theories* likely to stand, yet it affords much that may be used when the proper time arrives for the investigation of these theories. Thus the results of these alchemical investigations have not all stood the stern tests of time, but many truths have been derived from them, and when incorporated with the knowledge of after times, they have greatly aided in the formation of more perfect theories.

The course of preparation, prior to the nineteenth century, prepared the way for the more thorough investigation of the arcana of science; and with the way thus laid open for this purpose, the student has attained a knowledge altogether peculiar to his own day, and made the century pre-eminent for the investigation of nature and her laws. That such pre-eminence has resulted *from* a utilitarian tendency of the race can hardly be said with justice, since the two are rather coincident than occupying the relation of cause and effect. We should rather say, in the development of human knowledge it had become necessary that such investigations should take place, since the domain of pure thought, cultivated for centuries, and the polemics of medieval theology and philosophy studied fully in their ever-varying aspect,—had enlarged man's views of himself and the world around him, and compelled him, after he had followed the mental and spiritual interpretation of the oracular *Γνωθι σεαυτον*, to turn attention to its physical meaning,—to study the mysteries of his own organism and that of other beings likewise endowed with life,—the world in which he lived and the laws which govern it.

Such studies were, at first, mere gropings in the dark without one glimmer of light to direct his path. As time progressed, facts, isolated it is true, but nevertheless facts, were apprehended and a position assigned them in the store-house of memory, until at length the lamp of truth lighting up his path, he found these facts evidences of the existence of laws, and the harmonious proportions of system were given to the results of his labors. Physiology, and physical science, with its various subdivisions, gradually acquired the dignity of sciences. They have since been enriched by the labors of thousands toiling with a sincere desire to enlarge the boundaries of knowledge.

These two divisions of knowledge are of the greatest utility to each other,—so great indeed as effectually to prevent a knowledge of the one, where there is entire ignorance of the other. They are mutually explanatory. The physical sciences require a knowledge of physiology to aid to any conclusion as to the forms, matter is found to possess in organic structure,

and the Physiologist labors in vain if he is not possessed of a certain amount of knowledge which the physical sciences can give him.

In every living being, must be recognized the consummate wisdom of the Creator, who has seen fit to ordain a certain harmonious adaptation of means to ends; and since this adaptation presents itself with unerring accuracy in each species, we have styled it law,—that is an expression of His will with regard to that particular species. In the words of an English physiologist:* "These laws are framed by man as expressions or descriptions of the slight glimpses he possesses of the *plan* according to which the Creator sees fit to operate in the natural world. Thus understood, the use of the term law can be, in no way, supposed to imply, that the Deity stands in any other relation to the phenomena of the universe than as their direct and constantly operating cause."

In man, both mentally and physically, there seems to be a concentration of all the wonders of creation, which the ancient philosopher, though far too ignorant to understand, considered of so much importance that he called him a Microcosm moving in the Macrocosm,—a little world, embodying all the wonders and mysteries of the great world around him. With this little world, in its physical relations, the science of physiology is concerned. In the explanation of the mysterious functions of life, it brings to its aid the knowledge of sciences that are purely physical in their character, receiving from none more assistance in casting light on these functions than from the science of chemistry. Since, however, the exact relation of chemistry is too often misunderstood, it is proposed as a subject not only interesting in its general nature, but as involving consequences of importance to our religious belief, to devote a few pages to the consideration of the *true relation which Chemistry holds to Physiology.*

Physiology, treating of the phenomena peculiar to life, in its widest sense, comprehends a description of the organs through which these phenomena are manifested,—that is, in-

* Carpenter's Introduc. to Hum. Phys.

cludes anatomy. Since these phenomena take place in accordance with certain laws, which are equally recognized in mechanics and in living beings, it has been the custom to attempt an explanation of all vital operations by pure mechanical rules. Acting on such premises man has been compared to a machine; and not only have poets labored to depict the excellencies of this machine, the harmonious adaptation of all its parts, and the transcendent accuracy with which its operations are carried on,—but the scientific man, forgetting all that is mysterious and wonderful in the structure of the human frame, and hence, necessarily, all that is peculiar to it as the habitation of the soul—the direct impress of its Creator,—has too often studied it as a mere machine, with a vital principle that he has improperly considered as of no more account than the main spring of a watch, or the steam generator of an engine. Such a view, however, of his wonderful habitation, so mysteriously connected with the animating principle which controls it for awhile and leaves it to decay and become loathsome to its brethren,—at one moment striving against all the destructive tendencies of nature, and at another yielding to them, and suffering all its parts to mingle with the common earth,—such a view, we say, is too low, paltry and insignificant for any but superficial observers of nature to adopt.

When chemistry began to shed some light on certain of the operations, which take place within the recesses of the body,—the figure changed, and though not much used in poetry under its new form, (since poetry eschews with hearty good-will all reference to mortars and retorts, alembics, beaker glasses, and the other pharaphernalia of the chemist's laboratory,) yet, as science had aided the physiologist to explain some of the workings of the body, with enthusiastic acknowledgments, he was ready to adopt chemistry as the interpreter of all its mysteries, and it is now compared to a laboratory. The figure was more rational than the preceding one, since certain actions of life can be *imitated* out of the body if organic matter be used for the purpose, and we can thereby bring explanation to clear up mystery, and to serve as a light to guide us in after examination. But nothing

is surer than that these chemical operations in the system, are continually held in check by a vital force. Indeed they may almost be considered as the destructive agencies of life, which are forever warring against its integrity, rather than the preservative agencies which build up and bind together its various parts. Again, vital actions, even when most chemical, vary either in kind or degree, from those exhibited in the laboratory, as well as in the time required for their performance. As an illustration of this, may be quoted; "The shortness of the time in which the aliment becomes acid in depraved digestion,—a series of changes being produced in a few hours, which would require in the laboratory as many weeks," and in cases of disease, "where the functions of the stomach are nearly suspended, whatever is introduced into it remains unchanged and even the nutritious mucilages are not digested."*

Fully aware of the folly of such comparisons, and not only folly, but the danger, since they induced men to build up theories on mere visionary notions, which theories impeded the progress of rational medicine by fencing it in with the whims and caprices of their authors, William Hunter is said to have spoken to his class, on one occasion, as follows: "Gentlemen, some physiologists will have it that the stomach is a mill, others that it is a fermenting vat, others again, that it is a stew-pan,—but in my view of the matter, it is neither a mill, a fermenting vat, nor a stew-pan, but a *stomach*, Gentlemen, a STOMACH."

The danger, however, does not rest in the probability that the treatment of disease may be wrong, which depends on the physician, considering the body as a mere machine or a laboratory; it goes still further, and tends to sap the foundations of our belief in the doctrines of revealed religion. He who is accustomed to overlook the origin of life and merely to view it as an aggregate of chemical phenomena, finds it not difficult to advance the notion, that life *itself* may be included under the same head, and that the vital principle is only another and more refined form of electricity, and he will not hesitate long

* Paris' Pharmacologia, 56.

before he considers *this* the primal creative force. Though early education may keep him from going to this extreme, yet, his one-sided examination of the phenomena of life, will lead him far in that direction. Hence, arise the daring disciples of Mesmer, and a host of other quasi-investigators, into the mysteries of life, who do not hesitate to materialize thought, and to boast a mastery over the minds of their fellows, by virtue of an electric influence which they *project* from themselves. Hence, also, arise the semi-scientific experiments of Reichenbach on Odyle, and a thousand others much less entitled, on score of mind, to respect than this veteran of science.

All this springs from a blind attachment to the belief, that since chemistry can aid us in the explanation of many actions of the body, therefore we must be indebted to her for a full explanation of life,—it springs from a wrong apprehension of the true relation which chemistry bears to physiology,—a misconception of the true use of the former in explaining the latter.

Chemistry, in its widest range, can only give man a knowledge of the ultimate constituents of matter, the combinations of which they are susceptible, the laws governing such combinations, and the forces thereby developed. But matter presents itself in two forms,—one called unorganized, which is gifted with certain general properties, among which is prominent what has been called vis inertiæ—a kind of indifference as to what state or condition it may occupy,—the other called organized, which presents a marked contrast to the first, from its being produced in living beings, having its condition under the control of a vital force. The first can be separated into smaller portions,—be removed from its physical connections, while the second being produced in living beings, when separated from them speedily yields to the destructive processes of nature. The first is solely governed by the laws of natural philosophy and chemistry; the second only yields to them as modified by what is called the *vital* force, which force constitutes the mystery of physiology.

The vital force, from the very inception of life—the *punctum*

saliens of the organized being—acts in a different manner from any mere mechanical or chemical force, achieves results altogether unattainable by these latter, and is not to be explained by any analogies which may seem to exist between them and it. We can, it is true, reduce the whole mystery of animal life down to that of the existence of a single cell, which shall be absolutely microscopic in its character, and yet we will be foiled if we attempt to explain the production of this starting point of the organism by principles of either mechanics or chemistry. Its very simplicity is still too far above the grasp of mere physical science.

With bodies then made up, so to speak, of an aggregation of such cells, we must find it impossible to explain even this aggregation. Thus we find that there is a something connected with an *organism*, even from its origin, which is far beyond human ken. The very word itself—its derivation primarily from the Greek εργον—indicates its application to something which has a work or task assigned it by nature; and we find that an organism differs from a machine in being animated with one life, and requiring all its parts for its own perfection as well as for the conservation of that power in them, which prevents their subjection to the action of decay,—parts removed from the whole become dead, that is they yield to the laws which control inorganic matter; and parts removed from a machine are not changed at all in their structure nor in their tendency to decay; an organism has the power of repairing the losses of structure, which its own duties necessarily produce, and it only closes its activity when accident may check its operations, or the vital force may have accomplished the mysterious duties for which it was created; the machine gradually wears out, and in its greatest perfection, requires constant repair *ab extra*. There can, necessarily, be no comparison here. Are we more successful in our comparison, if we avail ourselves of all the discoveries of modern chemistry to illustrate the nature of that vital force which builds up and gives character to an organism, and then compare it to chemical action? Are the actions of organs to be explained by the doc-

trines of chemical affinity, or are the organic constituents governed by any such affinity? Let us examine an example. Among the organic constituents are found two, albumen and fibrine. On examination by the chemist, it is found that they are composed of the same elementary bodies, not widely differing from each other. Both contain carbon, hydrogen, oxygen, nitrogen, phosphorus and sulphur. The chemical difference does not give an insight into the different parts they play in the system. But the former acts as the material, out of which nearly all the tissues are formed, and shows nothing more than an aggregation of granules when examined microscopically. It is converted into fibrine by the vital force, and *then* we find indications of organization. How these are produced, the science of chemistry must ever fail to explain. And if we wish to make them obedient to the laws of chemical affinity, it is necessary first to remove them from the control of the vital force,—we must destroy the life which is in them and then we can subject them to the action of chemical agents. These two compound bodies, along with others, form organs having the same chemical constitution, though with widely different properties. The language of chemistry fails to give expression to the real uses of these two substances, since it is unvarying, while they are constantly changing in their properties.

This is but one instance. Instances might be multiplied to as many as there are proximate elements in the organism. They would all show as clearly as this one, that the relation chemistry bears to physiology is not that of an interpreter of the causes which originate life and the forces by which the integrity of its processes are carried on, nor of the relation of the structure of parts to the uses for which they are applied. To all, then, we can only assign the explanation that they are caused by the vital force, which is bound in the mystery that attends the origin of all matter,—a mystery not to be fathomed by finite mind.

This vital force pervades the whole range of organic life,—is seen in the monad which passes its brief existence in the sun beam,—in the vegetable, as it develops, from the small seed,

bark and wood, trunk and branches, until, as the grand old oak, it extends those branches, covered with myriads of leaves, wide and far, affording protection to man and beast,—in the zoophyte, frail occupant of the seeming transition line from vegetable to animal, with all its animal endowments bound down to a mere vegetating life,—in the beast that with wonderful instinct, seeks out the food necessary for its support, and boldly defends all attacks made against its own life,—and in man, with his far-reaching intellect, enabling him to subdue all the other productions of nature, and convert them into ministers to his wants, comforts and luxuries, whose consummately-formed frame exhibits the perfection of creation, and whose mind and soul mirror forth, dimly though it be, the image of his Creator. In all this range, the vital force manifests its presence,—indescribable in words, but known and felt by us all as a something that supports and preserves the whole from the destruction that is ever awaiting all matter, and from elements warring against it and one another. Like the spirit in Faust, "It moves up and down in the flood of life, in the storm of action it weaves hither and thither. Birth and death —an endless sea—a changing woof—a glowing life,—thus it works at the roaring loom of time and produces the living garments of the Deity."

Though this vital force gives character to organic matter, yet physiology has nothing to do with its essential nature or origin. The duties of this science are connected only with its manifestations and the laws regulating them. It can effect nothing, as we have seen, either by abstract chemical disquisitions on the nature of the vital force, nor by endeavors to bring it down to the simplicity of a mere physical agency; and it can also effect nothing by accumulating facts on facts, though they be mountain high, if such accumulation only results in the formation of hypotheses, manufactured from the vague, general resemblances which these facts may bear to each other. Such induction is at best, only calculated to deceive the lover of science in his wanderings through the realm of nature,—just as the *ignis fatuus* leads the benighted travel-

er over bog and marsh, until he is inextricably involved, while he is laboring under the delusive hope that he is nearing a place of security and protection. Facts have an importance in scientific investigations, but they aid in the establishment of hypotheses only when the means by which they were obtained are of a strictly philosophical character,—that is when they were obtained under the guidance of a sound logic, which does no violence, in the formation of an hypothesis to the materials from which it is formed, and hence produces such hypotheses as are altogether within the bounds of scientific probability.

It is well known that, in that positive form of reasoning—the logical syllogism—though the premises may be in themselves strictly correct—that is, *facts*—yet the conclusion derived from them may be false, on account of there being no proper logical connection between these facts. In like manner will all chemico-physiological conclusions be false, if there is no true logical relation between the facts from which they are deduced.

The aid chemistry brings to physiology consists in *measurably explaining the manifestations of the vital force and its operations in the human system*, not in explaining the nature and origin of this force. This is done by her researches, into the composition and metamorphoses of tissues, into the metamorphoses the ingesta undergo by virtue of certain chemical actions, into the products of secretion, and into the chemical changes which are brought about in a pathological state of the system. To support this statement, it will be necessary to advert briefly to these points.

The composition of tissues is connected as indissolubly with the functions they are expected to perform as their form. The three, *composition*, *form* and *function*, are so connected, that it is probable, as our knowledge of the human physiology increases, we may be able with any two of these factors to give the third. Form belongs to anatomy, function to physiology, composition to chemistry.

Of the elementary bodies, the sixty-three which have thus far resisted all efforts to be reduced to simpler forms, only

eighteen enter into the structure of the human frame. Of these carbon, hydrogen, oxygen and nitrogen, with a small amount of sulphur and phosphorus principally make up the structure. So long as the composition of tissues is of the normal chemical character, we have the organs which they form performing their duties in a normal way. Hence the necessity of knowing when this composition is changed, in order to judge of the effects of an abnormal composition, and to ward them off, if possible.

Whenever we recognize an organic constituent through its chemical properties in different parts of the system, whether composing tissues or fluids, we are enabled to reason as to the necessities which require its presence. In all such reasoning, we learn to recognize a positive necessity for the presence or absence of any organic constituent, and as these form the material from which the living body is formed or developed, we can trace the construction of tissues as connected with their uses, and also, to a certain extent, the nature of the metamorphoses they are subject to. The latter is a necessary subject for study, growing out of an attention to the nature of the composition of tissues. These must all, however, be studied, in full view of the fact that organic matter cannot be produced in the laboratory, and that a mysterious vital force accompanies,—guides all these operations. Reasoning, to be correct, must be chemico- physiological, as well as physiologico-chemical,—must require mere elemental constitution to understand *how* certain effects are produced, and have physiological knowledge of the existence of a vital force to understand *why* such effects occur at all. When "we have examined the origin and decomposition of a substance, we have obtained the firmest base for the explanation of the vital-chemical processes. After having familiarized ourselves with the organic substrata of the animal body, we are still only on the threshhold of the study of the composition and functions of the animal juices and tissues."* But with a firm basis for the superstructure we propose erecting, it must be seen that the composition of tissues

* Lehman's Phys. Chem., I. 12.

is then readily studied and their functions made intelligible.

As the system is constantly undergoing a waste of its particles, there must, necessarily, be some method of replacing them and of keeping up the integrity of the whole frame. Besides this necessity, there is another,—in the growing state it is absolutely necessary that the particles added shall exceed those removed. This is done by means of the *ingesta*, which are required to undergo certain metamorphoses before they are elaborated into the particular substances required for the nutrition and support of the body. These are of two kinds; one, which is more especially adapted to the construction and maintenance of organs, forming the plasmatic material out of which the tissues are formed, and the other, composed of starch and oleaginous bodies, forming the fatty tissues to be consumed through oxidation in the capillaries for the purpose of keeping up the heat of life. These two kinds of food are of such diverse character, that physiology can trace the effects of a deficiency of either, after she has learned the chemical constitution of the food. From observation alone, independent of chemical analogies, no such results could have been attained.

The first class of food is largely supplied with nitrogen, and as it has been proved that this is indispensable to all organic matter, the conclusion is readily arrived at, that it must be appropriated to the uses just mentioned, in the body. Upon an examination of this species of food, as compared with the wants of the body, theory suggests that a deterioration of the system would result from a continued use of it alone, and, in practice, the physiologist finds this idea fully substantiated. In the scurvy, for instance, the continued use of salted provisions is found to produce that general depraved condition of the system, which constitutes the disease. There has been too large a supply of animal matter. The administration of fresh vegetable juices restores a balance in the system,—the disease disappears and the system is again restored to health.

Other items of special importance also spring up from a chemical investigation into the nature of the ingesta. Food may be so changed by incipient putridity that a small quanti-

ty shall revolutionize the whole system. Formerly this was perfectly unexplainable. Now, although the cause may be bound up in mystery, yet the effect has been traced to its cause, and organic chemistry has shown that by the introduction of a small quantity of contagious matter into the blood, it there acts as a species of ferment and corrupts the whole. From this result, attention has been paid to the subject of the depravation of the blood, and many results have been obtained, which have been made of great service in the hands of physiology.

The second class of food is non-nitrogenized and adapted to the maintenance of animal temperature. This explains the enormous quantities of fat consumed by the inhabitants of northern climes, with whom even train oil is a delicacy. The intense cold, to which they are exposed, requires a large amount of internal heat to make up for that which escapes by radiation from the surface,—hence, large quantities of fuel, that is fatty substances, must be supplied to support the necessary combustion. The same thing is seen in inhabitants of a temperate clime. During an inclement winter they eat with relish fat meats which their palates utterly eschew when the almost vertical rays of the sun, in midsummer, fall upon them.

Having thus apprehended the exact uses of this kind of food, and the nature of the changes it is made to undergo in the system, physiology then proceeds to generalize upon it and finds the application, by way of explaining the reason, that some animals are carnivorous and others graminivorous.* The former, being active in their habits, have heat generated in this way, and require food similar in composition to their own flesh, merely to repair the waste of material which their constant activity produces; while the latter, on account of the freedom with which they perspire—that is throw heat off from the surface—require material which shall generate heat to make up this deficiency, and this material is found in the non-nitrogenized substances which make up their food. From these facts, reverting to man, we are ready to explain how an omnivorous ani-

* Carpenter's Human Physiology.

mal changes his food in obedience to the requirements of labor or the nature of the seasons,—selecting as the constant accompaniment of all his meals, when in a civilized condition, exactly such articles as combine the two kinds of food.

By means of *secretion*, certain substances are removed from the system, and others are elaborated for additional service. Here chemistry has shown the results of secretion and aided physiology in determining what may constitute the normal or healthy condition of the secreting organs, by showing her what are the products in a normal condition, and enabling her indirectly to apply proper therapeutic means when these are abnormal. Thus in pathology, which is but the physiology of disease, the relation of chemistry is that of an auxiliary, most reliable and indispensable. For though all the chemical actions, already adverted to, are under the guidance of the vital force, and hence by no means identical with operations in the laboratory, yet we can judge of the nature of their derangement by the changes which it produces in these actions. Deranged secretion itself is shown, in a majority of cases, to proceed, not from a local derangement of the secretory organs, but from a pathological condition of the blood, which provokes precisely the character of secretions, manifest on examination, being the effects of disease and not the cause. The treatment in all such cases, of course, requires attention to the prime cause of the disease.

The whole range of physiology is thus illumined by the torch, which chemistry holds up for its study. Without this light, the investigator of nature but follows blindly the sound of hollow theories, alike indicative of want of mental courage to grapple with the difficulties of his position, and of positive enfetterment in the chains of ignorance or superstition. This blind adherence to notions, which have the *authority* of the past, since that past had not the means of investigating a subject as fully as the present, is to be deprecated in matters of science. Our acquaintance with science itself is but as of yesterday; therefore the conclusions men have arrived at, before it was known at all, are of no avail, unless they shall be found

true and reliable, when examined by the light of the present. Reverence for the past is indispensable in the study of theology or history, when the past constitutes a necessary link in the whole chain, or rather when it acts as the trunk from which have been developed the sturdy limbs of the present. For the past of science this reverence cannot obtain to such an extent; there is a standard of truth, becoming more and more clear and reliable every day, by which all conclusions must be tried and must stand or fall by its decisions. Indeed, to a certain extent, our reliance on this standard, shows a high regard for the past, since, *it* is not the creation of a day, but the result of truths which have been deduced from the knowledge of all time.

The very advances made by physiology, through the aid of chemistry, have, however, made its students neglect too much the mystery of that life which pervades and gives its peculiar character to organized matter. They have become impatient of having any mystery connected with the actions of the body. Hence sentiments, like the following, occur far too often in treatises of the higher order, on the subject of physiological chemistry: "We cannot rest satisfied with the mysterious obscurity in which they (viz: vital phenomena and vital forces) have been artificially enveloped. We believe, with the diffidence beseeming a genuine student of nature, that it would be wiser and more conducive to the spread of true knowledge, to adhere, in the study of vital processes, to matter, and to the laws by which it is determined, than following the fictitious abstractions of dynamical processes, to assume that there exists in life a higher power of the spiritual force pervading matter."* Nor does the averment which follows—that "our most exalted conception of nature and the sublimest natural philosophy emanate from the very simplicity of physical laws and the unlimited variety of phenomena to which they give rise," relieve such views from their positive tendency to materialism.

It is becoming then, in the man of science, not to be so

* Lehman's Phys. Chem., I. 22.

blinded by the light she is shedding in his chamber, or over his researches in the laboratory, that he shall forget that far more brilliant light which streams with such resplendent rays that his mortal eyes are unable to receive their full splendor, and can only recognize their presence as reflected in the works of nature.

As to the practical utility of a proper understanding of the true relation which exists between chemistry and physiology, it might be sufficient to say that truth requires not to be sustained by arguments based on utility, but demands to be upheld and understood on account of its own merits. Here, however, utility manifests itself so plainly, that, independent of the truth involved in this question, the medical man must see, he can practice his profession more intelligently, when he comprehends the true nature of the aids science brings to the study of man, than when by a blind adherence to science alone, he merely looks at man as a grand illustration of its principles. In practice he will find that chemical laws are subject, in the human body, to the controlling power of something, which at times holds in check, and again hastens the play of chemical affinities,—that organized matter, so long as it remains under the dominion of this something, is not subject to chemical laws, but rather sets at defiance these laws and only bows down to them when it loses its connection with the living body.

Organic chemistry needs no fanatical support to present its discoveries in a proper point of view. Such support is always injurious. It attracts *some* friends, who may be enthusiastic, but also raises up many enemies. The good, therefore, derived from fanatical support, is more than overbalanced by the evil which necessarily accompanies it.

A wide field is open for study in organic chemistry,—a field as yet comparatively untilled, bearing near the surface the richest ore in return for the labor which shall be expended in its cultivation. To follow the course of inorganic matter, first into the vegetable kingdom, where it is elaborated and prepared for the wants of the animal, then its metamorphosis into organized tissue, the functions it is capable of under this form,

and finally its form and constitution when it is rejected from the organism;—to see that the highest efforts of chemistry have only succeeded in forming the *products* of organized matter, but have never approximated to the synthesis of a particle of this matter;—to see how affinity is held at bay by the force of vitality in the organs, and how coincidently with the departure of the latter it asserts its supremacy;—to examine with a careful eye to their utility the unvarying composition of the tissues in a state of health, and to mark how a change here indicates a morbid condition of the system;—to watch the progress of the life-giving blood, bearing its rich stream of nutriment to all portions of the body, and with its return current carrying off, to various points for their discharge, such particles as may be no longer needed to keep up its integrity,—these are subjects worthy of man's daily and nightly study,—the highest character of mind—the most extensive range of thought. They show that man is both "fearfully and wonderfully made." In such studies, we find that no act of life is performed without an accompanying destruction of some particles of matter belonging to the organs by which the act is performed,—that thus death is a constant attendant on life, and though an entire absence of action in the body implies its death, yet its life cannot be maintained without the death of some of its particles. Notwithstanding this continued wasting away of the organism, under favoring circumstances, neither its form nor faculties are injured, but the same power which dissevers effete particles, appropriates new material, so that the symmetry of the whole shall be kept up. This power is not found in inorganic matter. It is true, that when the latter is called upon to execute force, its particles have to change their relation to each other, but it has no inherent power to call in other particles of matter to replace those lost. This inherent power, self-constructive, self-preservative, and self-reproducing—peculiar to the organic kingdom—to that part of creation possessing life—is styled vital power, or vital force. It is a mystery bound up with the mystery of life itself.

Our subject has been chosen since it seemed to deserve care-

ful attention at the present time. The tendency of mankind is bearing it on towards the adoption of chemical explanations of all vital phenomena. We object to this, because some phenomena can only be examined so far as the laws which govern their appearance, the nature of the cause which produces them being beyond the range of human knowledge, and because such a tendency will deprive us of our belief in anything higher than matter and reduce all our thinking to mere materialism; and in addition to these objections, there is another, the natural consequence of a tendency to this extreme may produce from reaction, one in a very opposite direction, resulting in an entire opposition to all chemical study.

The domain of chemistry is wide enough for exploration without adding to it subjects which do not belong to its proper bounds. No science so richly deserves the commendation which Davy gave chemistry—"Its beginning is pleasure; its progress knowledge; its objects, truth and utility."